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Improved Photovoltaic Devices, Using Transparent Contacts

The use of transparent contacting materials results in improved solar cells and other optical detecting devices by: (a) increasing the high photon-energy response, (b) preventing series resistance problems, and (c) eliminating the requirement for expensive photolithographic contact techniques. The most serious problems in solar cells and other optical detectors are high surface and bulk recombination in the diffused side of the pn junction and series resistance caused by the sheet resistance of the thin diffused region. The solution of one problem causes a worsening of the other. Recombination losses can be reduced by making the junction depth very thin, but this increases the series resistance. Series resistance can be decreased by making the junction depth thick, but this increases the recombination loss.

Prior methods of minimizing these problems are elaborate and expensive, but the alternative method described here is neither. A pn junction is fabricated in the desired material (e.g., Si, GaAs, or InP) with a very narrow diffused region. The narrow junction minimizes the surface and bulk recombination losses in the diffused region. A transparent conducting coating is then applied to the junction surface (the coating can be made thick to prevent the series resistance problem). This coating provides an ohmic contact for majority carrier flow. If the coating does not block minority carrier flow, it is important that the diffused region be thin ($\sim$1,000 Å) to minimize the number of carriers generated in the thin diffused region.

Transparent conducting materials which can be used are SnO_2, In_2O_3, $(SnO_2)(In_2O_3)$, and $(SnO_2{:}SbO_2)$. In this manner, both the high photon-energy response and series resistance problems can be solved without expensive processing, and high-efficiency devices can be obtained.

This technique was applied using a GaAs pn junction with a sputtered $(SnO_2)(In_2O_3)$ coating. It was expected that a rectifying heterojunction barrier would be obtained rather than an ohmic contact. The discovery that an ohmic contact can be made to p-type material, using an n-type transparent conductor, or to n-type material, using a p-type transparent conductor, resulted in this improved photovoltaic device.

Note:

Requests for further information may be directed to:

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Patent status:

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